DOCUMENT RESUME

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IDENTIFIERS	*ABCs of Construction Project; Workplace Literacy

ABSTRACT

Developed by the ABCs of Construction National Workplace Literacy Project, these curriculum materials for the area of electrical and instrumentation contain a lesson that deals with reading charts and tables. The lesson consists of an objective, instruction, and 10 exercises. Three types of problems are provided in each exercise: "try it," "apply it," and "go with it." The objective for the lesson is for the student to learn to locate and apply information from a table. (YLB)

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TECHNICAL DEVELOPMENT CENTER
ED 374 289
CE 067 227

Reading Charts & Tables

ELECTRICAL & INSTRUMENTATION

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Associated Builders & Contractors, Inc.
EBR Adult & Continuing Education

ABC's of Construction
National Demonstration Project in Workforce Literacy

The ABC's of Construction Project was funded in 1991 by the U.S. Department of Education as a grantee through the National Workplace Literacy Program (PR #198A10155). The program provided basic skills instruction to industrial construction workers employed by companies which are members of the Pelican Chapter of Associated Builders and Contractors (ABC). Located in Baton Rouge, Louisiana, ABC provides training to employees of over 60 member companies who perform contract work in the 58 petrochemical facilities located along the Mississippi River between Baton Rouge and New Orleans.

The grantee, the Adult Education Department of East Baton Rouge School Board, performed a comprehensive literacy task analysis of the apprenticeship training program for millwrights, pipefitters, electricians, instrumentation techs, and welders involved in the ABC training program. Over 20 modules of original, contextual curriculum were developed to teach the reading and math skills required for success in the craft training program.

Materials developed for instruction incorporated cognitive strategies for learning basic skills in the context of the craft and safety knowledge demanded by the industrial construction workplace. Instruction was written for a competency-based, open-entry/open-exit, individualized adult learning program that operated at the ABC training center in the evenings after work-hours.

ORGANIZING INFORMATION WITH CHARTS AND TABLES

ELECTRICAL & INSTRUMENTATION

OBJECTIVE

You will learn to locate and apply information from a table

INSTRUCTION

The manager met with the crew. He told them the following:

"We're starting a new job. We'll work around plant schedules. We won't work regular hours. Some of you will work split shifts. Others will work regular shifts that start and end at odd times.

OK. Carl, you'll work Mondays and Tuesdays from 6 to 10 a.m.. You'll also work from 6 to 10 p.m. I'll need you from noon until 8 on Wednesdays. Thursdays you'll work your regular shift. On Friday I need you from 5 to 10 a.m. and from 3 to 6 p.m.

Vu, you work swing shift on Mondays and Fridays. I need you from noon to 8 on the other days.

Lynn, you'll have the same schedule as Carl except on Thursdays. You'll have the same schedule on Thursdays as Vu.

Don, you'll with Vu on Tuesdays and Wednesdays. On the other days, you'll work from 6 to 2.

Any questions?"

The schedules were different and new. There were too many changes. No one could remember when to work. Workers were late. Sometimes they failed to show up at all.

The answer to the problem was to make the following schedule.

CONSTRUCTION SCHEDULE

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon- 8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am- 2 pm	noon- 8 pm	noon-8 pm	6 am-2 pm	6am- 2 pm

Grouping work times by worker and day organized the schedule. The manager gave copies to each person. The schedule's structure helped workers see when they worked. This structure is called a chart, or table. The following chart is marked to show that structure.

CONSTRUCTION SCHEDULE

DAYS OF THE WEEK

COLUMNS

EMPLOYEES

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon- 8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am- 2 pm	noon- 8 pm	noon-8 pm	6 am-2 pm	6am- 2 pm

ROWS

First, workers found that a title told them what the table contained. The title appears at the top of the chart. The title of this chart is **CONSTRUCTION SCHEDULE.** Then they saw that information was organized by rows and columns. The rows ran horizontally across the page (left to right). The columns ran vertically down the page (top to bottom). Arrows show you an example of a row and column. Workers also found that information was grouped by a certain feature. Headings (or labels) showed them what was is the rows or columns. These are usually found on the top and left side of the chart. Top headings show what is in columns. Headings on the left tell what is in the rows. Examples of the labels are circled.

The schedule solved each person's problem. However, it solved it in different ways. Each person looked at different information to find when he or she worked. But, each person used the same process to find the information he or she needed. They had a purpose for using the chart. They needed to know when they worked. Each person found his or her name in the column on the left. Then that person looked for the day at the top. The place at which the row and column meets, or intersects, holds the needed information.

For example, Vu wants to know when he works on Wednesday. He finds his name on the left. He places his left index finger on his name. He finds Wednesday on the top of the chart. He places his right index finger on that label. He moves his fingers to the right and down. He comes to a box where they meet. That tells him when he works on Wednesday. He works from noon to 8 p.m. Shading on the following schedule shows you how Vu used the chart. The information he needed appears in a box.

CONSTRUCTION SCHEDULE

DAYS OF THE WEEK

EMPLOYEES	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon- 8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am- 2 pm	noon- 8 pm	noon-8 pm	6 am-2 pm	6am- 2 pm

The chart can be used in other ways. Vu wants to know how many times he works from noon to 8 p.m. Again, he finds his name on the left. This time he looks at all the information in the row. Each time he finds "noon-8 p.m." he looks up the column to that day. He finds that he works from noon to 8 p.m. on three days. These are Tuesday, Wednesday, and Thursday. The following chart is marked to show you how he found this information.

CONSTRUCTION SCHEDULE

DAYS OF THE WEEK

EMPLOYEES

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon- 8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am- 2 pm	noon- 8 pm	noon-8 pm	6 am-2 pm	6am- 2 pm

Now the manager needs information. He wants to call a meeting. He must find the earliest time when the crew can meet.

To do this, he must look at each day. He must find a time which is the same for everyone.

He looks at the heading for Monday. He compares each worker's schedule. He sees that Vu does not work in the morning. He then looks for an afternoon time.

Carl (6-10 p.m.) and Vu (4-12 p.m.) have the time 6 p.m. in common. He looks at Lynn's schedule. She can also meet at 6 p.m. He looks at Don's schedule. Don leaves at 2 p.m. The manager cannot schedule a meeting for Monday.

The manager looks at Tuesday. Again, Carl (6-10 p.m.) and Vu (noon-8-p.m.) can meet at 6 p.m.Lynn can also meet at 6 p.m.Don can meet at 6.p.m.

The manager schedules the meeting for 6 p.m. on Tuesday. This is the earliest time everyone can meet.

The schedule below is marked to show you how the manager found this information.

CONSTRUCTION SCHEDULE

DAYS OF THE WEEK

EMPLOYEES

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon-8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am-2 pm	noon-8 pm	noon-8 pm	6 am-2 pm	6am-2 pm

Now the manager wants to know something else. He needs to know how many times workers work a noon-8 p.m. shift. He doesn't care who it is. He doesn't care when they work. Now he doesn't need the labels. All he needs is the information within the chart. He looks at each box. He counts the number of times he finds "noon-8 p.m."

He looks down the columns. There are no noon-8-p.m. shifts on Monday.

He checks the next day. He finds two noon-8 p.m. shifts.

He looks at the third column. He finds four noon-8 p.m. shifts.

He checks the fourth column. He finds two more noon-8 p.m. shifts.

He looks at the last column. There are no shifts at that time.

He adds the shifts he counted—2 + 4 + 2. The total is 8. His crew works from noon-8 p.m. eight times in each week.

The following table shows you the information he found.

CONSTRUCTION SCHEDULE

DAYS OF THE WEEK

EMPLOYEES

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Carl	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	regular shift	5-10 am 3-6 pm
Vu	4-12 pm	noon- 8 pm	noon-8 pm	noon-8 pm	4-12 pm
Lynn	6-10 am 6-10 pm	6-10 am 6-10 pm	noon-8 pm	noon-8 pm	5-10 am 3-6 pm
Don	6 am- 2 pm	noon- 8 pm	noon-8 pm	6 am-2 pm	6am- 2 pm

Tables are often part of written information. They are also used alone for looking up specific facts. They organize many details for easy use. Reading a table is much like reading a paragraph. Tables have main ideas. Tables include many details. You can draw conclusions about the information in them. You use the headings as key words to help you find the information you need. You must get information you need from that which is not useful at that time. You may have to refer to more than one table in order to make comparisons, draw conclusions, or synthesize information.

The following steps are used in reading a table.

1. **READ THE TITLE OF THE TABLE.** This tells you its subject or general content. Some tables have no title Then you look at the contents and headings. This helps you determine the table's main idea for yourself.

2. **LOOK AT THE LABELS OR HEADINGS.** These tell you the items being compared. It also tells the features used to compare them. These form the key words which help you decide which column or row you need to find information.

3. **DETERMINE YOUR PURPOSE FOR READING THE TABLE.** Questions on the job often require you to use a table. Thus, tables are often used to find specific answers.

4. **READ ANY ACCOMPANYING WRITTEN DESCRIPTIONS.** Written descriptions provide the context for understanding the table. The description may highlight or clarify information in the table.

5. **RE-READ THE DESCRIPTION AND LABELS TO FIND INFORMATION.** Because tables organize information, they sometimes include information in shortened form. You may have to decide how features fit together. Reading and rereading helps you make decisions about what the information means.

Look at the steps in reading a table using the following information:

The Benfield Zip Guide (R), is an on-the-handle reference that speeds the work. This precalculated table for spacing between bends is accurate for any make of bender, whether hand-type, mechanical, or hydraulic. Zip-Guides (R) are a definite aid for the electrician.

ZIP GUIDE

FOR OFFSETS

Offset Depth Inches	Distance Between Bends	Angle Of Bends	Conduit Shortens
2	5 1/4	22 1/2	3/8
3	6	30	3/4
4	8	30	1
5	7	45	1 7/8
6	8 1/2	45	2 1/4
7	9 3/4	45	2 3/8
8	11 1/4	45	3
9	12 1/2	45	3 2/3
10	14	45	3 3/4

1. READ THE TITLE OF THE TABLE. The title of this table is "Zip Guide for Offsets."

2. LOOK AT THE LABELS OR HEADINGS. The headings are "offset depth inches," "distance between bends," "angle of bends," and "conduit shortens."

3. DETERMINE YOUR PURPOSE FOR READING THE TABLE. You might know that the offset depth you need is 5 inches. You want to know what the angle of bends can be. You find the number 5 in the offset depth column. You look to the right until you get to the heading "angle of bends." Your answer will be found at the place where that row and column meet. In this case, the answer is 45°.

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4. READ ANY ACCOMPANYING WRITTEN DESCRIPTIONS. In this case, the written description does not give additional information related to bend angles.

5. RE-READ THE DESCRIPTION AND LABELS TO FIND INFORMATION.

You might want to know where to find this Zip Guide. You look at the chart. You find no clue. You read the accompanying text. You find that two pieces of information which give you clues. These are highlighted in the information below:

> The Benfield Zip Guide (R), is an **on-the-handle reference** that speeds the work. This precalculated table for spacing between bends is accurate for **any make of bender, whether hand-type, mechanical, or hydraulic.** Zip-Guides (R) are a definite aid for the electrician.

Now you know that you find them on the handles of any kind of bender.

You have another problem. You are constructing offset bends of width depths of 8 inches. What should be the distance between bends?

First, you look at the headings. You find no label for offset bends. You do find one for offset bends in inches. You choose it. You look down the column for the number 8. Now you need to know the distance between bends. You do find a column marked "distance between bends." You look down that column. You look across the row for 8. They meet at the box marked "11 1/4". This is your answer. The distance between bends with 8 inch depths is 11 1/4.

Charts provide basic units of information. You may have do something with the information to find the answer you need. For example, a chart may tell how much a piece of conduit weighs. If you need to know how much 10 pieces weighs, you multiply the amount in the table by 10. For example, re-examine the Zip Guide Table. Let's say you must make 2 bends in a piece of conduit. Each one has an offset depth of 4 inches. You need to know how much the conduit will be shortened. You find 4 in column one and look for the heading "conduit shortens." You look for the place where the row and column meet. In this case, "1" is found in the place it meets. But, this is the answer for 1 bend. To determine the shortened amount for 2 bends you multiply the 1 from the table by 2, the number of bends. The conduit, then, would be shortened by 2 inches.

1 Exercise

Kim is completing a project. She must choose conductors, insulators and semiconductors. The plans do not tell which ones to use. She wants to use the best ones for the job. Kim gets her ABC manual. She reads the following:

CONDUCTORS

The valence shell can contain up to 8 valence electrons. Since valence electrons share any energy applied to them, the atoms that have less valence electrons will more easily allow those electrons to be freed. Materials that have electrons that are easily freed are called conductors. The atoms of conductors have only 1 or 2 valence electrons. The ones with only 1 valence electron are the best electrical conductors.

If you look at the atomic table, you can pick the good conductors. They all have one electron in their outer shell. Most metals are good conductors. The ones you are probably most familiar with are: copper (No. 29), silver (No. 47), and gold (No. 79).

INSULATORS

Insulators are materials from which electrons are very difficult to free. The atoms of insulators have their valence shells filled with 8 electrons or are more than half filled. Any energy applied to such an atom will be distributed amongst a relatively large number of electrons. But, in addition to this, these atoms resist giving up their electrons because of a phenomenon known as chemical stability.

An atom is completely stable when its outer shell is completely filled or when it has 8 valence electrons. A stable atom resists any sort of activity. In fact, it will not combine with any other atoms to form compounds. There are six naturally stable elements: helium, neon, argon, krypton, xenon, and radon. These are known as the inert gases.

All atoms that have less than 8 valence electrons tend to attain the stable state. Those that are less than half filled (the conductors), tend to release their electrons to empty the unstable shell. But those that are more than half filled (the insulators), strive to

collect electrons to fill up the valence shell. So, not only is it difficult to free their electrons, but these atoms of the insulators also oppose the production of electricity with their tendency to catch any electrons that may be freed. Those atoms that have 7 valence electrons most actively try to be filled, and are excellent electrical insulators.

SEMICONDUCTORS

Semiconductors are those materials that are neither good conductors nor good insulators. In other words, they can conduct electricity better than insulators can, but not as well as conductors can.

Semiconductors do not conduct electricity as well as good conductors because they have more than 1 or 2 valence electrons, and do not give up the electrons so easily. By the same token, semiconductors have less than 7 or 8 valence electrons, which is what insulators have. Thus, they do not resist giving up electrons as much as the insulators do, and therefore will allow some conduction.

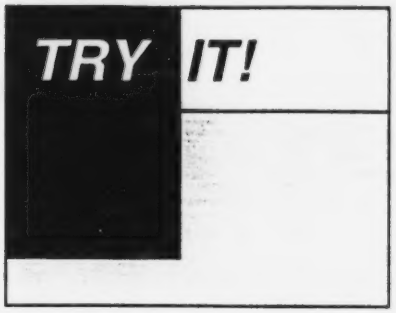
Generally, good conductors have their valence shells less than half filled, and good insulators have their valence shells more than half filled. So, a semiconductor is a material whose atoms are half filled. Those atoms have 4 valence electrons.

A review of the table shows that carbon, silicon, germanium, tin and lead are all semiconductors, since they have 4 electrons in their outer (valence) shell.

THE ELEMENTS AND THEIR ATOMIC SHELLS

Atomic No.	Element	Electrons per shell 1	2	3	4	5
1	Hydrogen, H	1				
2	Helium, He	2				
3	Lithium, Li	2				
4	Beryllium, Be	2	1			
5	Boron, B	2	3			
6	Carbon, C	2	4			
7	Nitrogen, N	2	5			
8	Oxygen, O	2	6			
9	Fluorine, F	2	7			
10	Neon, Ne	2	8			
11	Sodium, Na	2	8	1		
12	Magnesium, Mg	2	8	2		
13	Aluminum, Al	2	8	3		
14	Slicon, Si	2	8	4		
15	Phosphorus, P	2	8	5		
16	Sulfur, S	2	8	6		
17	Chlorine, Cl	2	8	7		
18	Argon, A	2	8	8		
19	Potassium, K	2	8	8	1	
20	Calcium, Ca	2	8	8	2	
21	Scandium, Sc	2	8	9	2	
22	Titanium, Ti	2	8	10	2	
23	Vanadium, V	2	8	11	2	
24	Chromium, Cr	2	8	13	1	
25	Manganese, Mn	2	8	13	2	
26	Iron, Fe	2	8	14	2	
27	Cobalt, Co	2	8	15	2	
28	Nickel, Ni	2	8	16	2	
29	Copper, Cu	2	8	18	1	
30	Zinc, Zn	2	8	18	2	
31	Gallium, Ga	2	8	18	3	
32	Germanium, Ge	2	8	18	4	
33	Arsenic, As	2	8	18	5	
34	Selenium, Se	2	8	18	6	
35	Bromine, Br	2	8	18	7	
36	Krypton, Kr	2	8	18	8	
37	Rubidium, Rb	2	8	18	8	1
38	Strontium, Sr	2	8	18	8	2
39	Yttrium, Y	2	8	18	9	2
40	Zirconium, Zr	2	8	18	10	2
41	Niobium, Nb	2	8	18	12	1
42	Molybdenum, Mo	2	8	18	13	1
43	Technetium, Tc	2	8	18	14	1
44	Ruthenium, Ru	2	8	18	15	1
45	Rhodium, Rh	2	8	18	16	1
46	Palladium, Pd	2	8	18	18	0
47	Silver, Ag	2	8	18	18	1
48	Cadmium, Cd	2	8	18	18	2
49	Indium, In	2	8	18	18	3
50	Tin, Sn	2	8	18	18	4
51	Antimony, Sb	2	8	18	18	5
52	Tellurium, Te	2	8	18	18	6
53	Iodine, I	2	8	18	18	7

Atomic No.	Element	Electrons per shell 1	2	3	4	5	6	7
54	Xenon, Xe	2	8	18	18	8		
55	Cesium, Cs	2	8	18	18	8	1	
56	Barium, Ba	2	8	18	18	8	2	
57	Lanthanum, La	2	8	18	18	9	2	
58	Cerium, Ce	2	8	18	19	9	2	
59	Praseodymium, Pr	2	8	19	20	9	2	
60	Neodymium, Nd	2	8	19	21	9	2	
61	Promethium, Pm	2	8	18	22	9	2	
62	Samarium, Sm	2	8	18	23	9	2	
63	Europium, Eu	2	8	18	24	9	2	
64	Gadolinium, Gd	2	8	18	25	9	2	
65	Terbium, Tb	2	8	18	26	9	2	
66	Dysprosium, Dy	2	8	18	27	9	2	
67	Holmium, Ho	2	8	18	28	9	2	
68	Erbium, Er	2	8	18	29	9	2	
69	Thulium, Tm	2	8	18	30	9	2	
70	Ytterbium, Yb	2	8	18	31	9	2	
71	Lutetium, Lu	2	8	18	32	9	2	
72	Hafnium, Hf	2	8	18	32	10	2	
73	Tantalum, Ta	2	8	18	32	11	2	
74	Tungsten, W	2	8	18	32	12	2	
75	Rhenium, Re	2	8	18	32	13	2	
76	Osmium, Os	2	8	18	32	14	2	
77	Irdium, Ir	2	8	18	32	15	2	
78	Platinum, Pt	2	8	18	32	16	2	
79	Gold, Au	2	8	18	32	18	1	
80	Mercury, Hg	2	8	18	32	18	2	
81	Thallium, Tl	2	8	18	32	18	3	
82	Lead, Pb	2	8	18	32	18	4	
83	Bismuth, Bi	2	8	18	32	18	5	
84	Polonium, Po	2	8	18	32	18	6	
85	Astatine, At	2	8	18	32	18	7	
86	Radon, Rn	2	8	18	32	18	8	
87	Francium, Fr	2	8	18	32	18	8	1
88	Radium, Ra	2	8	18	32	18	8	2
89	Actinium, Ac	2	8	18	32	18	9	2
90	Thorium, Th	2	8	18	32	19	9	2
91	Protactinium, Pa	2	8	18	32	20	9	2
92	Uranium, U	2	8	18	32	21	9	2
93	Neptunium, Np	2	8	18	32	22	9	2
94	Plutonium, Pu	2	8	18	32	23	9	2
95	Americium, Am	2	8	18	32	24	9	2
96	Curium, Cm	2	8	18	32	25	9	2
97	Berkelium, Bk	2	8	18	32	26	9	2
98	Californium, Cf	2	8	18	32	27	9	2
99	Einsteinium, E	2	8	18	32	28	9	2
100	Fermium, Fm	2	8	18	32	29	9	2
101	Mendelevium, Mv	2	8	18	32	30	9	2
102	Nobelium, No	2	8	18	32	31	9	2
103	Lawrencium, Lw	2	8	18	32	32	9	2



1. Where is the title of the chart?

_____

2. What is the title of the chart?

_____

3. This is a special kind of chart. List ALL the headings at the top.

_____

_____

_____

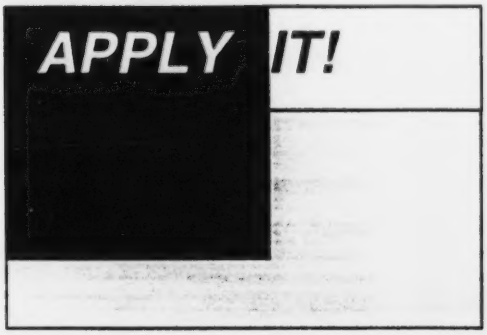
4. What do you notice about them? How is this different from other charts?

_____

5. How will this affect the way you will use the chart?

_____

_____



1. Kim is trying to decide which materials to use in her project. The project design prohibits her from using copper. Gold and silver are too expensive. Out of the following, what group of elements would make the best conductors?

A. Polonium, Mercury, Lead
B. Potassium, Iodine, Xenon
C. Sulfur, Chlorine, Argon
D. VK<KD,iC, Cesium, Francium

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) The table does not have a heading for "conductors." How did you know where to look?

_____

_____

(d) Why aren't the other elements good conductors?

_____

_____

2. Which of the following elements does not match its symbol?

A. Samarium, Sm
B. Tin, Sn
C. Antimony, Sb
D. Mercury, Me

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Now Kim must choose a group of insulators. Out of the following, what group would be best?

A. Chlorine, Astatine, Bromine
B. Magnesium, Nitrogen, Thallium
C. Americium, Lawrencium, Tungsten
D. None of the above are good insulators.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

(d) What is the definition of an insulator?

_____

4. Kim found one material labeled "W." What element is it?

A. Zirconium
B. Tungsten
C. Osmium
D. Lutetium

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

5. In reading, Kim finds the text lists 5 semiconductors. These are silicon, carbon, lead, germanium, and tin. From the following, what other semiconductors might Kim choose?

A. Radon, Europium, Iridium
B. Thallium, Berkelium, Indium
C. Niobium, Hydrogen, Helium
D. None of the above are good semiconductors.

(a) What is the definition of a semiconductor?

_____

_____

(b) Where did you find that definition?

_____

_____

(c) How did you use the definition to help you find the answer?

_____

6. **Kim must make notes about the materials she uses. What would be the symbols for each of the elements in your responses for questions 1,3, and 5?**

Question 1

_____

Question 3

_____

Question 5

_____

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

7. **Which of the following elements is most stable?**

A. Platinum
B. Lithium
C. Argon
B. Nitrogen

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

8. According to the table, what is the maximum number of electrons you can have in each shell?

Shell 1 _____

Shell 2 _____

Shell 3 _____

Shell 4 _____

Shell 5 _____

Shell 6 _____

Shell 7 _____

Shell 8 _____

(a) What headings did you use to find the answers?

_____

_____

(c) How did you find the answers?

_____

_____

9. **Kim has the following elements. Would she classify them as insulators, conductors, or semiconductors?**

Beryllium _____

Technetium _____

Rhodium _____

Xenon _____

Carbon _____

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

10. What is the symbol of the element associated with each of the following atomic numbers?

No. 70 _____

No. 83 _____

No. 37 _____

No. 9 _____

No. 100 _____

(a) Is the answer to this question found in the table? _____

(b) How did you know?

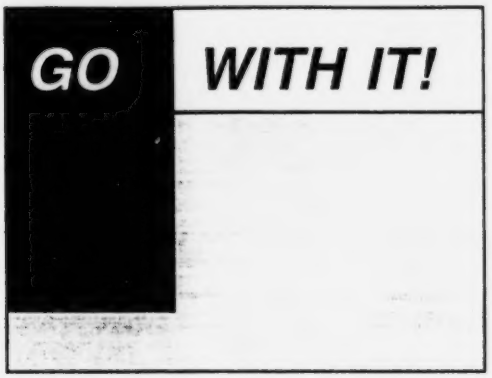
_____

_____

(c) How did you find the answer?

_____

_____



1. List 5 other things you can find from this information.

EXAMPLE: The number of atomic elements

1. _____

2. _____

3. _____

4. _____

5. _____

2. What reasons might you have to use this information?

_____

_____

_____

_____

25

24

2 Exercise

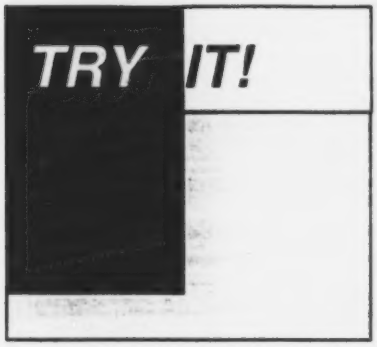
Jeff is installing wiring in a refinery. The wiring will be exposed to corrosive materials. His supervisor tells him to construct rigid conduit raceways. Jeff must determine the size and amount of conduit he needs. He refers to the following:

DIMENSIONS OF CORROSION-RESISTANT RIGID CONDUIT.

The internal and external diameters for aluminum conduit are thesame as those for rigid steel conduit. The internal diameter of plastic-coated rigid conduit, of course, is the same as that of standard rigid steel conduit. The outside diameter of theplastic-coated is slightly greater. The external diameter ofconduit of silicon bronze alloy is practically the same as that of rigid steel conduit, but its internal diameter is slightly greater, as shown in Table 60A.

60A. Everdur Rigid Conduit
(American Brass. Anaconda Co.)

Nominal size, in.	Nominal dimensions, in.			Unit length without couplings, ft.-in.	Min weight of 10 unit lengths of conduit with couplings attached, lb
	Diameter		Wall thickness		
	Outside	Inside			
¼	0.540	0.382	0.079	9-11½	40
⅜	0.675	0.503	0.086	9-11½	55
½	0.840	0.636	0.102	9-11¼	86
¾	1.050	0.834	0.108	9-11¼	115
1	1.315	1.075	0.120	9-11	164
1¼	1.660	1.382	0.139	9-11	242
1½	1.900	1.614	0.143	9-11	288
2	2.375	2.077	0.149	9-11	380
2½	2.875	2.519	0.178	9-10½	553
3	3.500	3.084	0.208	9-10½	790
3½	4.000	3.548	0.226	9-10¼	980
4	4.500	4.026	0.237	9-10¼	1.160



1. Where is the title of the chart?

_____

2. What is the title of the chart?

_____

3. This is a special kind of chart. List ALL the headings at the top.

_____

_____

_____

4. What do you notice about them? How is this different from other charts?

_____

5. How will this affect the way you will use the chart?

_____

_____

APPLY IT!

1. **Jeff needs conduit with a minimum outside diameter of one inch. The maximum outside diameter should be no more than two inches. What nominal size conduit should he use?**

A. 1/2
B. 3/4
C. 1
D. 1 1/4

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. **Jeff must install a 50-foot run of wire. Excluding the couplings, what is the least number of conduits he needs for the job?**

A. 4
B. 5
C. 6
D. 7

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. **The place where Jeff will install the wiring cannot hold much extra weight. Jeff will use conduit with a 2 inch nominal size. What is the weight of ten unit lengths of conduit, including couplings?**

A. 149
B. 911
C. 553
D. 380

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. Jeff looks at the table. He finds the unit length of conduit without couplings varies according to nominal size. How many different lengths did he find?

A. 12
B. 3
C. 5
D. none of the above

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

5. Jeff uses the table to decide how much conduit to load on a truck. Of the following, what two nominal sizes of pipe have the LEAST difference in weight?

A. 3 1/2 and 4
B. 2 and 1 1/2
C. 1 and 1 1/4
D. 1 1/4 and 1 1/2

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

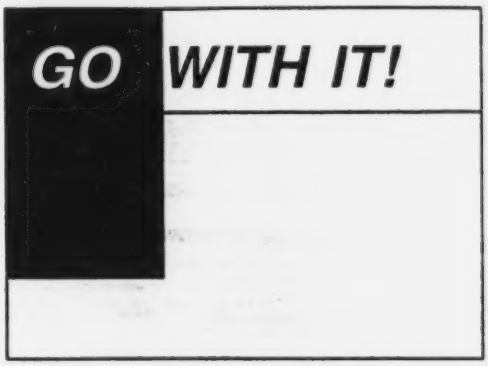
_____

(c) How did you find the answer?

_____

30

_____



1.) List 5 other things you can find from this information.

EXAMPLE: Comparisons between outside and inside dimensions

1. _____

2. _____

3. _____

4. _____

5. _____

2.) What reasons might you have to use this information?

_____

_____

_____

_____

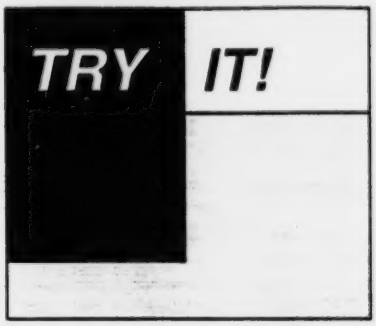
_____

3 Exercise

Rex is replacing mechanical room equipment. Vibration is a problem. He uses flexible raceways for the wiring. He must determine the sizes and amounts he needs. He refers to the following:

B. Nominal inside diameter inches	A. Minimum OD, inches	Bending radius inches	Approximate ft. per coil	Minimum weight lb/1000 ft.
5/6	0.470	1 3/4	250	150
3/8	0.560	2	250	255
1/2	0.860	3	100	470
3/4	1.045	4	50	595
1	1.300	5	50	1020
1 1/4	1.550	6 1/4	50	1250
1 1/2	1.850	7 1/2	25	1625
2	2.350	10	25	2125
2 1/2	2.860	12 1/2	25	2630
3	3.360	15	25	3130

Fig. 9-74 Flexible Steel Conduit



1. What is the title of this chart?

_____

2. How many sizes of conduit are shown on the chart?

_____

3. How many things can you learn about any single size of conduit?

_____

4. Choose one size of conduit. Fill in the information for each of the following:

Nominal inside diameter _____

Minimum OD _____

Bending Radius _____

Approximate feet per coil _____

Minimum weight lb/1000 ft _____

5. What does each of these symbols or abbreviations mean?

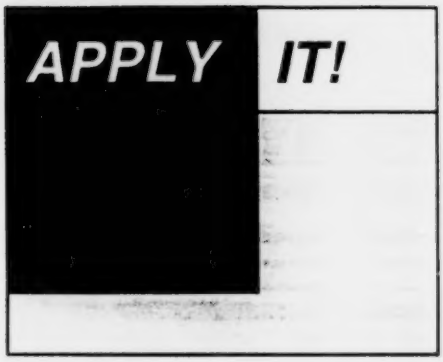
B _____

A _____

in _____

ft _____

33



1. Rex needs conduit with an inside diameter of at least one inch. Space is limited. Thus, the outside diameter must be less than two inches. What nominal size of conduit might Rex use?

A. 1
B. 1 1/4
C. 1 1/2
D. all of the above

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. A truck delivers a coil of conduit to Rex. The length of the coil is 100 feet. What is its nominal inside diameter?

A. 3/8
B. 1/2
C. 3/4
D. 1

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Rex is using 3 inch conduit. What is the approximate minimum weight of 500 feet of it?

A. 1000 lb
B. 1500 lb
C. 2000 lb
D. 3000 lb

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. The job requires 60 feet of 1 1/2 inch conduit. How many coils will Rex need?

A. 1
B. 2
C. 3
D. 4

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

5. Rex is using 2 1/2 inch conduit. What is its bending radius?

A. 12 1/2
B. 15
C. 10
D. 7 1/2

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

GO WITH IT!

List three questions you could answer with this chart.

EXAMPLE: Which conduit size has the greatest bending radius?

_____

_____

_____

_____

37

36

4 Exercise

Zandra is replacing wiring in a chemical company. She uses electrical metallic tubing (EMT). She usually uses flexible conduit. She has forgotten the dimensions for standard 90° elbows in EMT. She rereads the following:

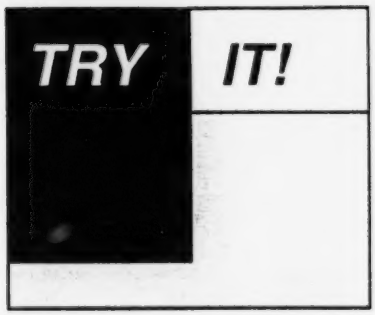
SECTION 186

All outlet boxes and fittings for use with EMT must be of the threadless type, since owing to the thin wall it is not permissible to thread the tubing. Special threadless fittings similar to those employed for standard rigid conduit are manufactured for tubing. Standard rigid conduit fittings can be used with tubing if an adaptor is employed. Sections of tubing can be joined by means of threadless couplings, which are available in steel and malleable-iron construction. Tubing is connected to outlet boxes by means of connectors. One end of the connector is made for threadless attachment to the tubing, and the other end is threaded and supplied with a locknut for attachment to the box through a knockout. Rain-tight connections can be made to the tubing with some couplings and connectors. Standard 90° elbows are attached to the tubing by means of the above-described couplings. The dimensions of standard elbows are given in Section 187. Rain-tight elbows and angle-box connectors are available with the ends fitted with threadless fittings.

SECTION 187

(All dimensions in inches)

Trade size of tubing	Smallest acceptable radius R to center line of tubing	Shortest acceptable length Ls of each straight end portion of tubing
1/2	4	1 1/2
3/4	4 1/4	1 1/2
1	5 3/4	1 7/8
1 1/4	7 1/4	2
1 1/2	8 1/4	2
2	9 1/2	2
2 1/2	10 1/2	3
3	13	3 1/8
4	16	3 3/8



1. What is the title of this chart?

_____

2. What is the content of the chart?

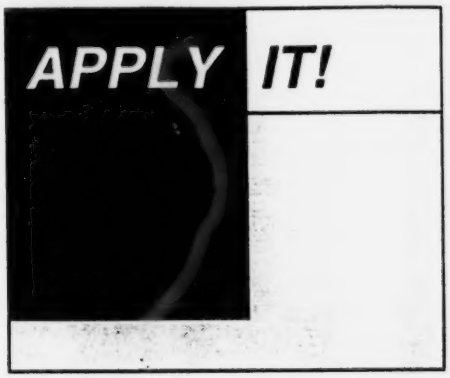
_____

3. What two things can you find out about each size?

_____

39

38



1. How many trade sizes of tubing are available?

A. 7
B. 8
C. 9
D. 10

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. Zandra uses 2 inch tubing. What will be the smallest acceptable radius R to the center line of the tubing?

A. 8 1/4
B. 9 1/2
C. 10 1/2
D. You cannot tell from this chart.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Zandra's supervisor checks the work. He finds the shortest acceptable length Ls of each straight end portion of tubing to be 2 inches. What trade size tubing did Zandra use?

A. 1 inch
B. 2 inch
C. 3 inch
D. 4 inch

(a) Is the answer to this question found in the table? _____

(b) How did you know?

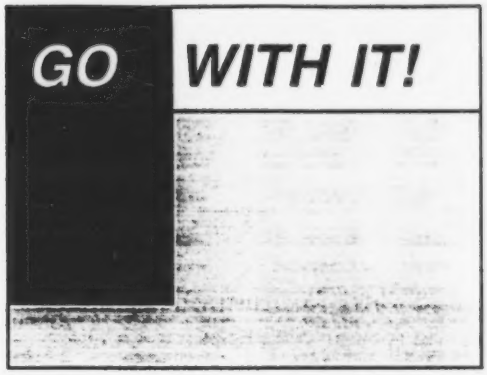
_____

_____

(c) How did you find the answer?

_____

_____



Write 5 facts you can get from this information (chart or text).
Use your own words.

EXAMPLE: Threadless fittings are used with EMT.

_____

_____

_____

_____

42

41

5 Exercise

Jeff used to work for a company which supplied wiring for construction projects. Now he is starting the ABC E & I program. He remembered he filled a lot of orders for copperweld products. He had wondered how the different kinds of wiring were used. In looking through his AMERICAN ELECTRICIAN'S HANDBOOK he finds the following information:

(See the page 41 for the chart.)

111. Application Guide for Copperweld Products

Product	Companies and uses					
	Power companies	Railroad	Electric railway	Telephone and telegraph	Municipal	Construction mill, etc.
Bare wire	Telephone and signal lines Overhead ground wire Grounding wire Lightly loaded lines Tie wires, mousing wire Light guys Remote-control lines Counterpoise wire	Signal, telegraph, and telephone lines Control circuits Overhead ground wire Grounding wire Bond wires, tie wires CTC circuits	Telephone and signal lines Overhead ground Light span wire Light guys	Line wires Guys Antenna wire	Police and fire-alarm circuits	Telephone lines Grounding wire Crane trolley Pipe-insulation wrapping wire
Copperweld-copper*	Copperweld-copper cables of numerous combinations for long spans, rural distribution, and transmission conductors	Copperweld-copper Catenary messenger Feeder cables for electrification	Copperweld-copper Catenary messenger Feeder cables			Copperweld-copper Cables for long spans
Weatherproof and plastic-jacketed wire	Telephone and signal lines Remote control	Signal lines, control circuits, tie wires Centralized traffic control circuits	Telephone and signal lines	Tree wire Grounding wire Line wire	Signal and alarm circuits Tie wires	Signal and alarm circuits
Rubber- and neoprene-covered	Drop wires for telephone and signal lines	Drop wires for telephone signal lines	Drop wires for telephone lines	Drop wires and block wire	Alarm circuits Drop wires	Telephone and signal lines Drop wires

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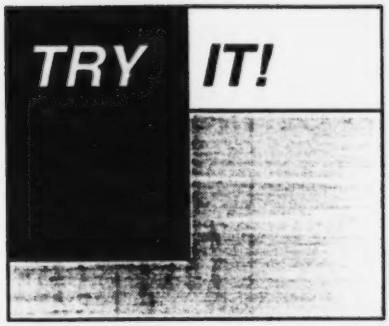


1. What is the title of this chart?

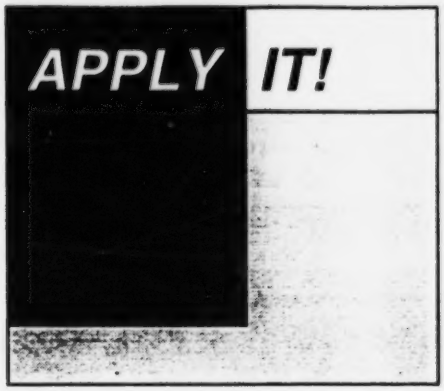
_____

2. How many products are shown on this chart?

_____

3. How many different kinds of companies are shown on the chart?

_____



1. Which of the following has the greatest variety of uses for bare wire?

A. Southern Lines Railroads, Inc.
B. Rapides Parish Power Company
C. The City of Ruston, LA
D. Southern Telephone Company

(a) How did you find the answer?

_____

_____

2. Which of Jeff's former customers might use weatherproof and plastic-jacketed wire as tree wire?

A. Big 3 Power Company
B. City Transit Electric Railway Corp.
C. ZAP Telegraph Co.
D. Ajax Construction Co.

(a) How did you find the answer?

_____

_____

3. Jeff filled a lot of orders for rubber and neoprene covered wire. What is it used for most often?

A. overhead ground wire
B. guys
C. feeder cables
D. drop wires

(a) How did you find the answer?

_____

_____

4. Which of the following companies seem to have no use for copperweld-copper wire?

A. Bi-State Power Company
B. Bell Telephone
C. EZ Construction
D. Transway Railroad

(a) How did you find the answer?

_____

_____

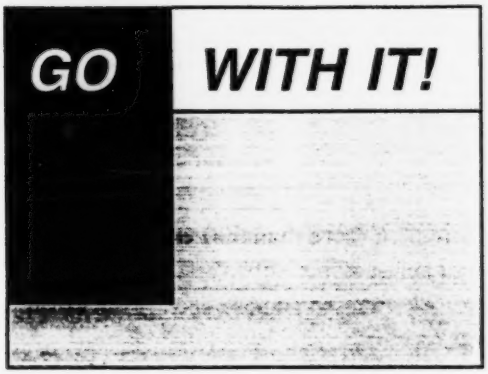
5. City Electric Company is installing some additional phone lines. What kinds of wiring might they purchase?

A. Bare wire
B. weatherproof and plastic-jacketed wire
C. Rubber and neoprene covered wire
D. All of the above.

(a) How did you find the answer?

_____

_____



Sometimes information in a chart can be regrouped. This gives you a new look at the information. Complete this new chart.

TYPES OF WIRE USED
(PRODUCT NAME)

	Drop-Wires	Telephone Wires	Signal Wires
Railroad			
Electric Railways			
Construction Mill			

6 Exercise

Al is installing electrical panels. All have ratings of more than 600 volts. Al must decide where to put each one. His company cannot afford mistakes. Such corrections would be made at company cost. Al wants to be sure each installation meets NEC Code. He checks the following:

110-34. Work Space and Guarding.

(a) Working Space. The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, motor controllers, relays, and similar equipment shall not be less than specified in Table 110-34(a) unless otherwise specified in this Code. Distances shall be measured from the live parts if such are exposed, or from the enclosure front or opening if such are enclosed.

Where the "Conditions" are as follows:

1.) Exposed live parts on one side and no live or grounded parts on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated bus-bars operating at not over 300 volts shall not be considered live parts.

2.) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces.

3.) Exposed live parts on both sides of the work space (not guarded as provided in Condition 1) with the operator between.

(See page 47 for the chart).

TABLE 110-34(a)
Minumum Depth of Clear Working Space
in Front of Electric Equipment

Nominal Voltage to Ground	Conditions		
	1	2	3
	(feet)	(feet)	(feet)
601 - 2500	3	4	5
2501 - 9000	4	5	6
9001 - 25,000	5	6	9
25,000 - 75 KV	6	8	10
Above 75 KV	8	10	12

1. What is the title of this chart?

_____

2. Describe each of the three conditions of working space.

Condition 1

_____

_____

Condition 2

_____

_____

Condition 3

_____

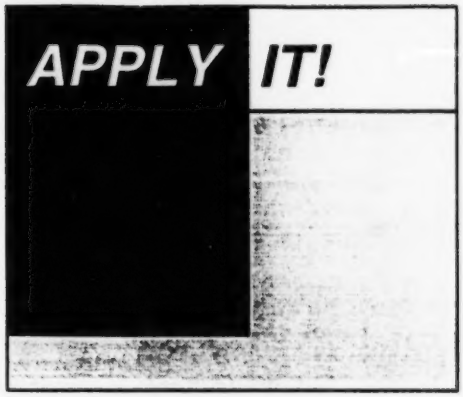
_____

3. Which condition do you think is most dangerous? Why?

_____

52

51



1. The first panel's voltage to the ground is 100 kV. Both sides have exposed live parts. What is the minimum depth of clear working space Al needs?

A. 8
B. 10
C. 12
D. none of the above are correct

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. One panel will be in a room with exposed live parts on both sides of the work space. The operator will be between the work space. The panel's nominal voltage to ground is 10,000 volts. What minimum depth of clear working space is needed?

A. 5
B. 6
C. 9
D. You cannot tell from this chart.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. One panel will be placed on a concrete (grounded) wall. It will have exposed live parts on the other side. It has a rating of 1000 volts. What is the minimum depth of clear working space needed?

A. 1
B. 2
C. 3
D. 4

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer? 54

_____

53

_____

4. Al installed a panel with live parts on both sides. These parts were effectively guarded by insulation. The panel's voltage was 50 kV. Al installed it with a working space depth of 3 feet. What might Al's supervisor say?

A. "Good job."
B. "You didn't need that much clear working space."
C. "The minimum depth of clear working space should be twice what you gave it."
D. None of these comments are appropriate.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

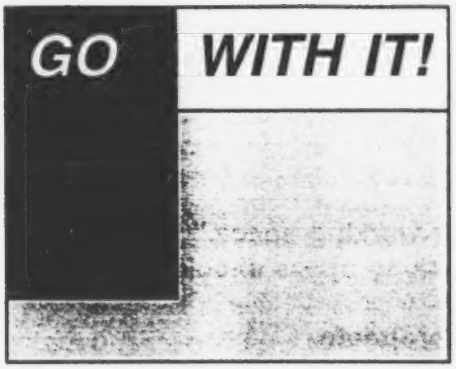
_____

_____

(c) How did you find the answer?

_____

_____



List 5 facts you find in this information.

7 Exercise

RHA Construction is upgrading a plant's electrical system. Joe's crew will use rigid metal conduit for some work. They must install it in an existing building. Thus, they must work around some machinery and fixtures already in place. They must meet code requirements. As the crew's supervisor, Joe refers to the following:

> **346-10. Bends—How Made. Bends of rigid metal conduit shall be so made that the conduit will not be damaged, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in Table 346-10.**

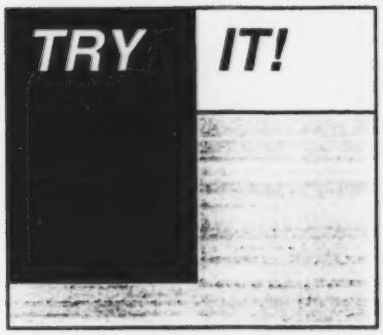
TABLE 346-10.
Radius of Conduit Bends

(All dimensions in inches)

Size of Conduit	Conductors	Conductors Without
1/2	4	6
3/4	5	8
1	6	11
1 1/4	8	14
1 1/2	10	16
2	12	21
2 1/2	15	25
3	18	31
3 1/2	21	36
4	24	40
5	30	50
6	36	61

56

57



1. What is the title of this chart?

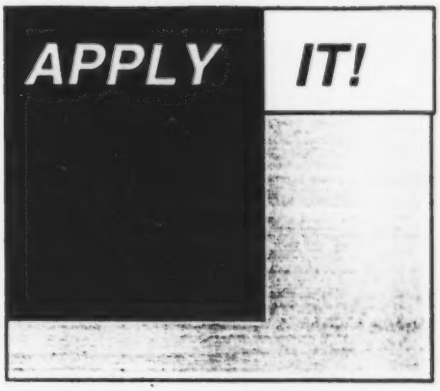
_____

2. What two kinds of conduit are being compared?

_____

_____

_____



1. The first run uses 3 inch conduit. Joe plans to use conductors without a lead sheath. What radius should he use?

A. 15
B. 31
C. 18
D. 21

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. Joe's next run uses 1 1/4 inch conduit. The conductors do not have lead sheaths. What should be the radius of conduit bends?

A. 8
B. 14
C. 16
D. 10

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. The next run will use 1 inch conduit. Joe can use conductors with OR without a lead sheath. Which kind would give a greater radius of conduit bends?

A. with a lead sheath
B. without a lead sheath
C. There's no difference between them.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. Joe can use either ? or 3 inch conduit. He will use conductors without a lead sheath. What is the difference in radius of conduit bends between these sizes?

A. 6
B. 12
C. 18
D. 31

(a) Is the answer to this question found in the table? _____

(b) How did you know?

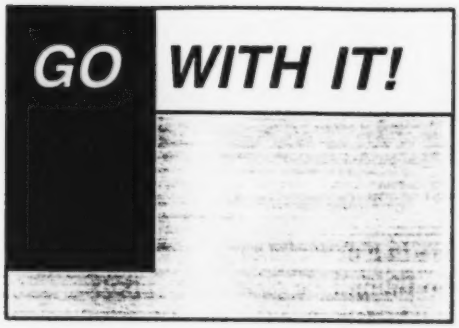
_____

_____

(c) How did you find the answer?

_____

_____



Create a new chart. Arrange the items in order from smallest radius bend to largest. If two sizes have the same bend radius, put the smaller size of conduit first. Indicate if the conduit is with or without a sheath. The first five have been done as an example.

Conduit Size	Radius Bend
1/2 without	4
3/4 without	5
1/2 with	6
1 without	6
3/4 with	8
1 1/4 without	8
1 1/2 without	10

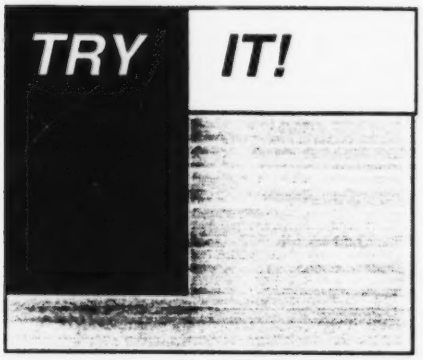
61 62

8 Exercise

Lyman installs electrical equipment. He works in a new chemical plant. The place where he works will often be exposed to flammable gases and vapors. Lyman uses a code to mark equipment. The code describes maximum temperature ranges. He refers to the following NEC table:

Table 500-3(b) Identification Numbers

Maximum Temperature: Degrees C	Degrees F	Identification Number
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6



1. What is the title of this chart?

_____

2. What is the difference between degrees C and degrees F?

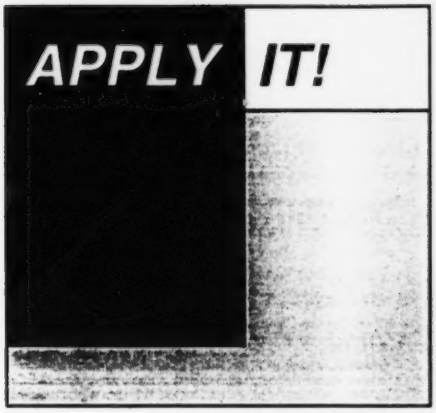
_____

_____

_____

3. How many identification numbers are in the code?

_____



1. The maximum temperature in an area is 120°C. What code should Lyman use?

A. T5
B. T4A
C. T3A
D. T6

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

65

64

2. Lyman marked a piece of equipment as T2C. What maximum temperatures can it withstand?

A. 215°F/419°C
B. 160°C/320°F
C. 230°F/446°C
D. none of the above

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Lyman knows that the temperature in one place will get to 500°F. He marks equipment in that area T2B. Lyman's supervisor checks his work. What might he say?

A. "OK."
B. "You should have marked it T3B."
C. "No marking is required for this equipment."
D. none of the above

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. Lyman looks over the chart. He finds a relationship between the numbers for Degrees C and those for Degrees F. What is the relationship?

A. Degrees C are approximately double those of Degrees F
B. Degrees C are approximately half of those of Degrees F.
C. Degrees C and Degrees F are about the same.
D. No relationship exists between Degrees C and Degrees F.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

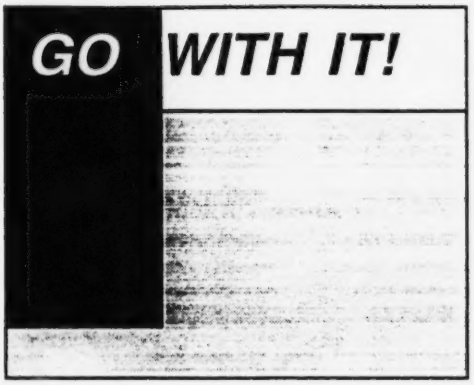
_____

_____

(c) How did you find the answer?

_____

_____



Pick five numbers between 85 and 900. How would each be marked if it is degrees C? What would be the marking if it were degrees F? If the number is not listed on the table, choose the next highest marking.

EXAMPLE: The mark for 225°C would be T2C.

1) _____

2) _____

3) _____

4) _____

5) _____

9 Exercise

Danya works in a large factory. She installs motor controllers in nonhazardous locations. She must choose the kind of enclosure to use for each installation. She refers to the following NEC handbook information:

430-91. Motor Controller Enclosure Types.
Table 430-91 provides the basis for selecting enclosures for use in specific nonhazardous locations. The enclosures are not intended to protect against conditions such as condensation, icing, corrosion, or contamination which may occur within the enclosure or enter via the conduit or unsealed openings. These nternal conditions require special consideration by the installer and/or user.

Table 430-91. Motor Controller Enclosure Selection Table

Provides a Degree of Protection Against the Following Environmental Conditions	For Outdoor Use: Enclosure Type Number†						
	3	3R	3S	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X
Rain, snow and sleet	X	X	X	X	X	X	X
Sleet*	—	—	X	—	—	—	—
Windblown dust	X	—	X	X	X	X	X
Hosedown	—	—	—	X	X	X	X
Corrosive agents	—	—	—	—	X	—	X
Occasional temporary submersion	—	—	—	—	—	X	X
Occasional prolonged submersion	—	—	—	—	—	—	X

* Mechanism shall be operable when ice covered.

Provides a Degree of Protection Against the Following Environmental Conditions	For Indoor Use: Enclosure Type Number†										
	1	2	4	4X	5	6	6P	11	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	—	X	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers and flyings	—	—	X	X	—	X	X	—	X	X	X
Settling airborne dust, lint, fibers and flyings	—	—	X	X	X	X	X	—	X	X	X
Hosedown and splashing water	—	—	X	X	—	X	X	—	—	—	—
Oil and coolant seepage	—	—	—	—	—	—	—	—	X	X	X
Oil or coolant spraying and splashing	—	—	—	—	—	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—	X	X	—	—	—
Occasional temporary submersion	—	—	—	—	—	X	X	—	—	—	—
Occasional prolonged submersion	—	—	—	—	—	—	X	—	—	—	—

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1. What is the title of this chart?

_____

2. Why are there two charts?

_____

_____

_____

3. How are the two charts different?

_____

_____

4. How are the two charts alike?

_____

_____

5. What does "X" mean in the chart?

_____

6. What does "-" mean in the chart?

_____

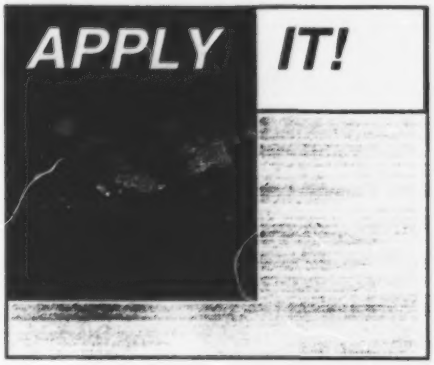
7. What is an "environmental condition?"

_____

_____

8. Look at both charts. How many different kinds of enclosures are there? (NOTE: Don't count any twice.)

_____



1. Danya is installing a motor controller in a pumphouse. It may be exposed to oil sprays or splashes. What kind of enclosure should she use?

A. 6P
B. 2
C. 4X
D. 13

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

72

71

2. One controller will be outside of a building. The area will be hosed down for cleaning. Which enclosure would be appropriate?

A. 3
B. 3R
C. 3S
4. 4

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Danya installed an exterior controller. She used a 6P enclosure. What environmental conditions would ruin the controller?

A. submersion in water
B. corrosive agents
C. sleet
D. windblown dust

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. Danya compares indoor conditions with outside conditions. What environmental conditions exist both inside and outside?

A. corrosive agents
B. submersion
C. hosedown
D. all of the above

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

5. Danya installed a controller enclosure in an place exposed to airborne dust, occasional hosedowns, and falling dirt. She used a type 5 enclosure. What might her supervisor say?

A. "OK."
B. "That enclosure will not withstand falling dirt."
C. "That enclosure is not appropriate for inside use."
D. "That enclosure will not withstand a hosedown.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

Choose any indoor enclosure type. Write a sentence which describes the conditions it protects. This means you will read down the chart and name the conditions with an "X."

EXAMPLE: Enclosure 1 protects against incidental contact with enclosed equipment and falling dirt.

75

74

10 Exercise

Ajay is installing wiring in a petrochemical plant. Ajay's supervisor said to use rigid aluminum conduit. Ajay usually installs flexible raceways. He reviews information about rigid aluminum conduit from his AMERICAN ELECTRICIAN'S HANDBOOK.

65. Rigid aluminum conduit. The use of aluminum conduit has gained wide acceptance because of its light weight, excellent grounding conductivity, ease of threading, bending, and installation, resistance to corrosion, and low losses for installed ac circuits. Installations of rigid aluminum conduit require no maintenance, painting, or protective treatment in most applications. Because of its high resistance to corrosion this conduit should be used in many severely corrosive industrial environments such as sewerage plants, water treatment stations, filtrations plants, many chemical plants, and installations around salt water.

When aluminum conduit is buried in concrete or mortar, a limited chemical reaction on the conduit surface forms a self-stopping coating. This prevents significant corrosion for the life of the structure. However, calcium chloride or similar soluble chlorides sometimes are used to speed concrete setting. In limiting the use of such speeding agents, the American Concrete Institute and most building codes recognize that embedded metals can be damaged by chlorides. As a result, if aluminum conduit is to be buried in concrete, the installer should be absolutely sure that the concrete will contain no chlorides. If there is any doubt, rigid steel conduit should be used, because even though chlorides can damage steel conduit to some degree, this will not lead to cracking or spalling of concrete.

Although aluminum conduit can be buried safely in many soils, precautions are recommended because of unpredictable moisture, stray electric current, and chemical variations in almost every soil. To assure protection when buried directly in earth, aluminum or steel conduit should be coated with bituminous or asphalt paint, wrapped with plastic tape, or encased in achloride-free concrete envelope.

Table 66, Aluminum Rigid Conduit: Nominal 10-Ft. Lengths

Trade size	Lb per 100 Ft	No. per bundle	Lb per bundle*	Master shipping package			
				Bundles	Pieces	Feet	Lb
1/2	29.8	10	29.8	20	200	2,000	596
1/4	39.8	10	39.8	20	200	2,000	796
1	58.9	10	58.9	10	100	1,000	589
1 1/4	79.8	5	39.9	10	50	500	399
1 1/2	95.6	5	47.8	10	50	500	478
2	128.8	5	64.4	9	45	450	580
2 1/2	204.7	1	20.47	LOOSE	30	300	614
3	268.0	1	26.8	LOOSE	20	200	536
3 1/2	321.3	1	32.13	LOOSE	20	200	642
4	382.1	1	38.21	LOOSE	20	200	764
5	521.5	1	52.15	LOOSE	8	80	417
6	677.5	1	67.75	LOOSE	6	60	405

1. What is the title of this chart?

_____

2. How many trade sizes are shown?

_____

3. What three things can you find out about each single piece of conduit?

_____

_____

4. What can you find out about a master shipping package?

_____

_____

77

78

1. The first installation calls for conduit embedded in concrete. Ajay reads the information accompanying the table. What should he consider in using aluminum conduit?

A. corrosion
B. crushing the conduit with the concrete
C. the presence of chloride in the concrete
D. all of the above.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

2. Ajay reads that calcium chloride is often added to concrete. Why?

A. to speed setting times
B. to reduce corrosion
C. to make it stronger
D. to prevent cracking

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

3. Ajay is ordering conduit. He orders the following: 1 bundle 3/4 inch conduit, 2 bundles 1 inch conduit, and 2 bundles 1 1/2 inch conduit. What is the total number of feet of conduit?

A. 3000
B. 3500
C. 4500
D. 5000

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

4. Ajay needs 100 feet of 6 inch conduit. How much will that weigh?

A. 677.5 lb.
B. 406 lb.
C. 67.75 lb.
D. You cannot tell from this table.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

5. Ajay orders 1 bundle of 2 1/2 inch conduit. How many pieces are in the bundle?

A. 10
B. 5
C. 1
D. 30

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

6. Ajay orders a master shipping package of 2 inch conduit. How many pieces will he receive?

A. 100
B. 50
C. 30
D. 45

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

7. One run requires 50 feet of 4 inch conduit. How many pieces should Ajay order?

A. 50
B. 10
C. 4
D. You cannot tell from this table.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

81 82

8. **Ajay orders a master shipping package of 4 inch conduit. How many pieces are in a bundle?**

A. 20
B. 9
C. You cannot tell from this table.
D. None, the pieces are not delivered in bundles.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

9. **Ajay is moving large amounts of conduit with rigging. He adjusts the rigging for the number of pounds he must move. His last load was for 1 bundle of 3/4 inch conduit. Now he is moving 1 bundle of 1 1/4 inch conduit. How should he adjust the rigging?**

A. The rigging must be stronger because 1 1/4 inch conduit is heavier.
B. The rigging need not be as strong because 3/4 inch conduit is heavier.
C. There is no difference in the weights.
D. You cannot tell from this table.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

_____

_____

(c) How did you find the answer?

_____

_____

10. One installation requires that the conduit be buried in dirt. According to the accompanying reading, what should Ajay do to protect the conduit?

A. Set it in concrete first.
B. Wrap it in plastic tape.
C. Paint it with asphalt paint.
D. All of the above.

(a) Is the answer to this question found in the table? _____

(b) How did you know?

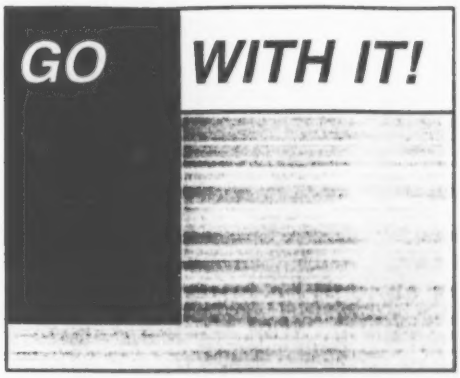
_____

_____

(c) How did you find the answer?

_____

_____



Choose any trade size of conduit. Write a sentence which describes what a master shipping package would contain. (NOTE: Read across the chart)

EXAMPLE: A master shipping package for 1/2 inch conduit has 20 bundles with 200 pieces totaling 2000 feet and 596 lbs.

85

84